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U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF

THE BOTANIST

FOR

1890.

BY

GEORGE VASEY.

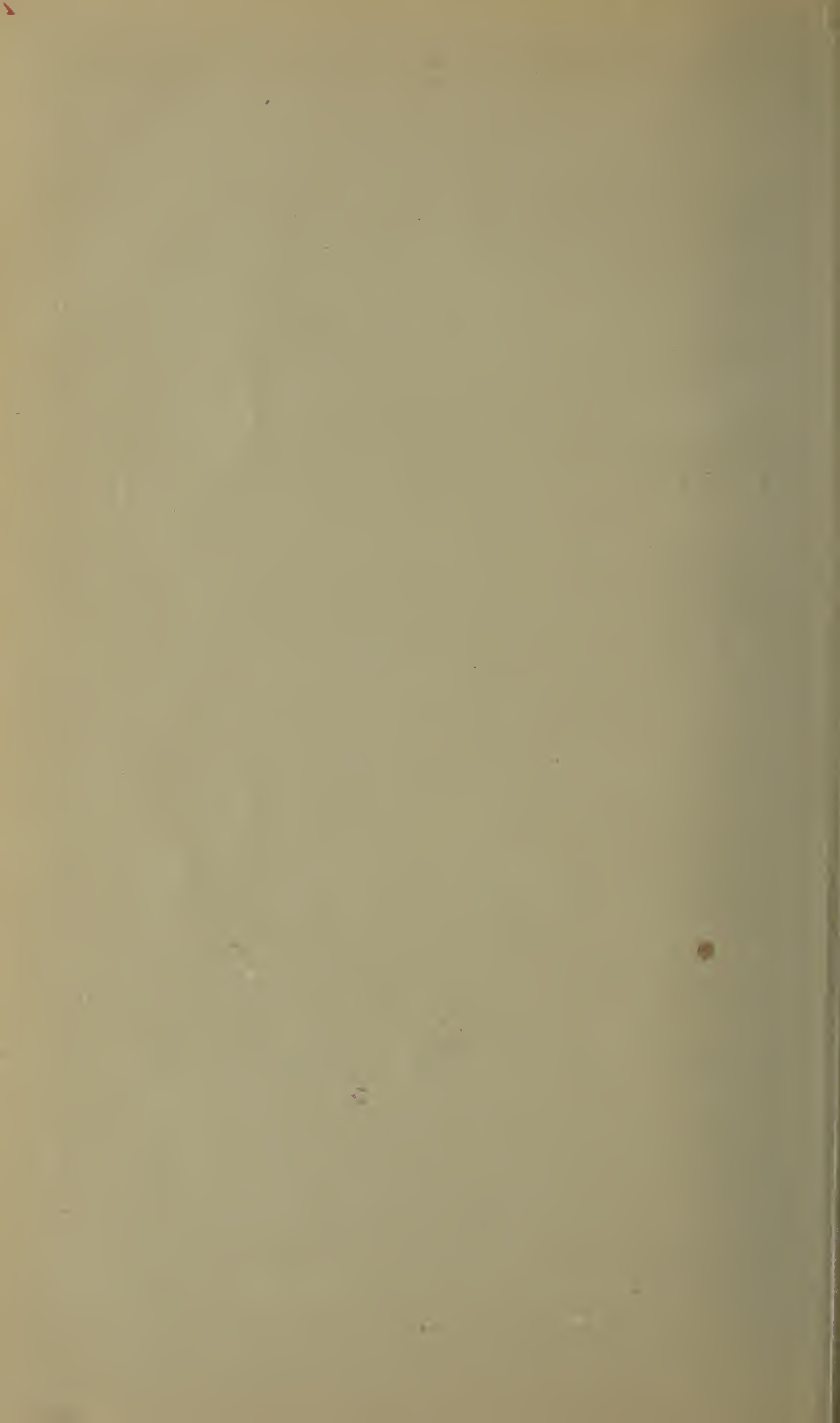
FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1890.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

Office of
Experiment Stations.

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Ans'd.....



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REPORT OF THE BOTANIST.

SIR: I have the pleasure of presenting herewith a report of the work of this Division for the year 1890. The report contains a general statement of the concerns of the Division and a few short papers on matters of general interest. The articles on forage experiments in Kansas and in Mississippi are preliminary to full reports to be presented for publication as bulletins.

Respectfully,

GEO. VASEY,
Botanist.

Hon. J. M. RUSK,
Secretary.

INTRODUCTION.

The Section of Vegetable Pathology having been created into a separate Division, its work will be separately reported upon.

The appropriation for the Botanical Division provides for experiments with forage plants, the development of the herbarium, and other economic botanical work, mentioning specifically that upon medicinal plants.

FORAGE EXPERIMENTS.

Grass Experiment Station at Garden City, Kansas.—The Station was established in August, 1888, with Dr. J. A. Sewall, of Denver, as superintendent. A short account of the plan of experiments undertaken in the year 1889 is given in the report of the Botanist for that year. During the present year these experiments have been continued and others instituted, so that with the added experience of the previous year encouraging indications of practical and valuable results have been attained. A statement of the experiments and processes is given on page 383.

Grass experiments at Agricultural College, Mississippi.—By an agreement between the Secretary of Agriculture and Prof. S. M. Tracy, Director of the State Agricultural Experiment Station of Mississippi, a series of forage experiments has been for two seasons conducted in that State under the direction of the Botanist of this Department and the superintendence of the director of the Station. By this arrangement the expense of leasing land and putting up buildings was saved to the Department, and excellent management of the experiments was insured. The Station itself is benefited by the direct interest of the Department in its forage questions and by its ability to make immediate local application of the results. A preliminary report of this work is given on page 378.

OTHER EXPERIMENTS.

The results attained at the Garden City Station are only in a general way applicable to the whole area of the arid lands. The climatic conditions vary exceedingly, even within this area, and while over a comparatively large portion the experiments and methods here used are satisfactory, for other portions it is necessary to make new experiments and to test the methods first found useful. To accomplish this end arrangements have been made with the United States Agricultural Experiment Stations at Fort Collins, Colorado, and Tucson, Arizona. About 5 acres of land was prepared at each of those stations, and sown to seeds of grasses and forage plants, with very poor results, probably due in part to the newness of the land. The experiments will be continued. Arrangements have been made with the Experiment Station at Las Cruces, New Mexico, and the Experiment Station at Logan, Utah, for grass and forage experiments next season.

HERBARIUM.

During the last two years means have been given to the Division to make collections of plants in little known regions, to provide for their identification, and to publish the results.

During the present year Dr. Edward Palmer, an old and experienced collector, has explored remote parts of Lower California, Western Mexico, and Arizona, making valuable collections, which add materially to the knowledge of the botanical character and resources of those regions. Mr. J. H. Simpson was employed from May to August, inclusive, to collect plants in the region of Manatee, Florida. He collected such species as were known to be rare, or not to have been found there previously, and made an annotated list of all the plants of that district. Mr. G. C. Nealley, of Houston, Texas, has been collecting since April 15, in Western Texas, for the most part in the desert lands. He was directed to make collections of as nearly as possible all the plants seen, and to take note of such as promised to be of value in the forage experiments. The plants collected in 1888, 1889, and the present year form the basis of a flora of Western Texas, now in preparation by Prof. J. M. Coulter under the direction of the Botanist. On the 15th of September Mr. C. R. Orcutt, of San Diego, California, started on a collecting trip for the Department in the Colorado Desert of Southern California. The specimens from this excursion have not yet been received. Other collectors have been employed for shorter periods, and have added materially to the growth of the herbarium.

The continuation of this method of obtaining specimens will enable the Department to have fully represented in the herbarium the plants of regions before little explored, and will insure a valuable stock of specimens for exchange. It will be possible before the lapse of many years to prepare, from the data now accumulating, handbooks covering the botany of the southwestern States and Territories. Since the establishment of the United States Agricultural Experiment Stations, there has been an especial demand for such publications.

In addition to the specimens collected by the Division others have been received in exchange, by purchase, and by contribution, so that the number of sheets added to the National Herbarium during the year July, 1889, to July, 1890, is about 6,000.

Exchanges of specimens from the herbarium have been carried

on ever since its establishment. Most of these exchanges have been made for the purpose of adding desirable specimens to the collection; but with certain institutions, namely, the State Agricultural Colleges, the exchanges assumed the character of a duty. The Division has continued to donate specimens and is desirous to aid the colleges in every practicable way. Within the last few years several of the Experiment Stations, not having access to any herbarium, have applied to the Department for aid, and have received sets of accurately identified economic plants. These sets have been found especially necessary for reference by the Station botanists in the naming of forage plants under experiment.

MEDICINAL PLANTS.

The work on medicinal plants thus far done by the Division has been confined, for want of sufficient means, to the illustration and description, in the Annual Reports, of a small number of native species known to have value in medicine. The object of such reports was merely to enable persons of little botanical education to identify the plants. In certain portions of the United States the collecting of native drugs is an important local industry. It is proposed to continue the investigation of our native medicinal plants, with reference to their commercial and economic relations. It is desirable to make experiments in the collection of such kinds as are becoming scarce in the wild state. Many requests come to the Department for seeds of the well known medicinal plants of foreign countries, with the view of attempting their cultivation. An effort will be made to obtain a supply of seeds of such kinds as are suited to our climate.

PUBLICATIONS.

Until the present year all the publications of the Division, except the Annual Report of the Botanist, were issued in a series of bulletins. The subject-matter of these bulletins was of so varied a nature and was directed to such different classes of readers that it was found desirable to institute a new series of publications to contain matter not of direct economic importance. This was accordingly done, by authority of the Secretary, and the title "Contributions from the United States National Herbarium" was adopted. The economy of this course lies in the fact that a smaller edition of these publications is required, and a separate mailing list is kept for them. The Bulletins henceforward will contain economic reports, the Contributions scientific matter. Since my last Annual Report the following publications have been issued:

Special Bulletin. The Agricultural Grasses and Forage Plants of the United States, by Dr. George Vasey. A new, revised, and enlarged edition, with 114 plates. 1889. (Pp. 1-148, with 114 plates engraved on wood, 8°.)

Bulletin No. 12. Grasses of the Southwest: Plates and Descriptions of the Grasses of the Desert Region of Western Texas, New Mexico, Arizona, and southern California. Part 1. By Dr. George Vasey. Issued October 13, 1890. (Pp. 1-8+100 [unnumbered], with 50 lithograph plates, royal octavo.)

Contributions from the United States National Herbarium, No. 1. Issued June 13, 1890. I.—List of plants collected by Dr. Edward Palmer in 1888 in southern California; by George Vasey and J. N. Rose. II.—List of plants collected by Dr. Edward Palmer in 1889 at (1) Lagoon Head, (2) Cedros Island, (3) San Benito Island, (4) Guadalupe Island, (5) head of the Gulf of California; by George Vasey and J. N. Rose. (Pp. I-VIII+1-28, 8°.)

Contributions from the United States National Herbarium, No. 2. Issued June 28, 1890. Upon a collection of plants made by G. C. Nealley in the region of the Rio Grande, in Texas, from Brazos Santiago to El Paso County. By John M. Coulter. (Pp. I-IV+29-61+index, 8°.)

INSECURITY OF THE HERBARIUM.

The present insecurity of the National Herbarium from fire is the cause of constant anxiety to those acquainted with its condition. The collections have an actual market value of about \$20,000, and as certain portions could never be duplicated if destroyed, an additional value, hardly to be estimated in money, is given. So fully is the necessity of safe quarters realized throughout the United States that the American Association for the Advancement of Science, at its annual meeting for 1890 in Indianapolis, passed resolutions calling the attention of the Secretary of Agriculture and of the Secretary of the Smithsonian Institution to the present insecurity of the Herbarium, and expressing an earnest desire that measures be taken to insure its safety. Taking into consideration the need of safer quarters and the inadequacy of space in the present building, it is earnestly recommended that a commodious fire-proof building, or portion of a building, be provided for the National Herbarium.

MISSISSIPPI EXPERIMENT STATION.

By S. M. TRACY.

In 1888 Congress made provision for the prosecution of experiments in the culture of forage crops, under the supervision of the Department. One of the stations for this work was located at the State Experiment Station at Agricultural College, Mississippi, and placed in charge of S. M. Tracy, the director of the Station. Seeds of all the species which could be found in the markets were procured, and correspondents in India, Australia, and other foreign countries added many additional species. Seeds of the most promising native sorts were collected, and during the past two seasons one hundred and sixty-one species of grasses and thirty-eight of other forage plants have been under test. Nearly all of these have grown on three sets of plots in order to test their value for different soils, and thirty-seven of them have been cultivated in the field on areas of from 1 to 5 acres. Details in regard to the growth and character of each, their probable value for cultivation in the Gulf States, together with results of chemical analyses, digestion tests, etc., will be given in a special bulletin soon to be issued by the Department, while the general results with the leading sorts are summed up as follows:

With so many species, coming as they did from all parts of the world, it was not expected that all, or even many of them, would prove valuable for cultivation under the peculiar climatic and soil conditions which exist in the Gulf States, where the growing season for different plants extends nearly through the year, and where protracted summer drouths and excessive winter rains make it necessary that hay and pasture fields should be able to resist great atmospheric extremes. A large majority of the native forage plants in this region commence their growth late in the spring, but from about the 1st of April until December the pastures are abundant, and certain kinds of hay may be cut at any time from June to November. The great desideratum for this region is a plant which will make a fair growth for pasture during the cool and rainy months of the winter. Whatever may be used for this purpose should be a perennial, so

that fields need not be reseeded often; it should be adapted to great differences in soils; the roots should be able to endure continued drouth, and the forage must be relished by all kinds of stock. We have no plants which continue an active growth throughout the year, so that for a winter pasture plant we are obliged to look for one which will not be choked out and destroyed by other plants which occupy the ground during the summer months. Among those species which have succeeded the best have been the following:

ORCHARD GRASS (*Dactylis glomerata*).—This grass has given us a better winter growth on heavy clay soils, without attention, than has any other species which we have tested. It commences its growth with the first warm days of February, and if not pastured is ready to cut for hay in May, and will then afford excellent grazing until checked by the summer drouth. With the first fall rains it starts a new growth of leaves, making excellent fall pasture, and keeping fresh and green all winter. Its habit of growing in large clumps is against its use as a hay grass, but it bears grazing well, recovers quickly when cropped down, and makes its best growth during the cooler parts of the year.

RESCUE GRASS (*Brumus unioides*).—This is an annual winter grass which produces even more abundantly than does the orchard grass, when sown on rich and not too heavy soil, but requires more care in its management. If sown in September or October it will usually make a heavy growth during the fall, and is often ready to cut for hay as early as February, and may be cut once or twice more before June. It disappears on the approach of hot weather, and if it is desired to make the field a permanent meadow should not be cut after April, so that the last growth may ripen seed. With favorable rains the seed will germinate in September or October, and will then furnish abundant food during the winter. Where stock can be taken from the pasture in time to permit the maturing of the seed the grass will be practically permanent, but if this is not done it will disappear after two or three seasons. Sown with equal care it will give a better winter pasture than either oats or rye, and in the spring can be plowed under with equal advantage as a fertilizer. When properly handled it is one of our most valuable sorts, but unless it receives attention to secure it an opportunity for self-seeding it can not be relied on to form a permanent sward.

WATER GRASS (*Paspalum dilatum*).—This is a perennial species which is indigenous throughout the Gulf States, and which seems well worth cultivating. It grows from 3 to 5 feet high, bears drouth well, and will grow on almost any soil. It is somewhat difficult to propagate, as many of the seeds fail to germinate and it spreads slowly from the roots, but when once established it lasts indefinitely, remains fresh and green through the winter excepting for a few days after severe freezes, and is easily killed out when it is desired to bring the field into cultivation. It grows best on low ground, but when it has been planted on dry clay hills it has made an excellent growth, and now (November 15) covers the ground with a dense mass of fresh green leaves. It bears grazing well, is relished well by all kinds of stock, and may be safely recommended for any locality south of latitude 35°. We do not know that the seed has ever been offered for sale.

CARPET GRASS (*Paspalum platycaule*).—This is a perennial species which is indigenous to the southern part of the country, and which has spread northward until it is now found occasionally as far north

as Starkville, Mississippi, but which is not abundant excepting along the coast region. Its flat and spreading habit makes it of no value for hay, but it furnishes excellent grazing during nearly the entire winter. It grows best on rather low lands, and will bear closer grazing and more tramping than any other grass we have. It starts slowly from the seed, but when once established it grows rapidly, and a single plant will cover from 10 to 20 square feet in a season. It roots at every joint like the Bermuda, but unlike that, it can be readily destroyed by cultivation. In favorable locations it occupies the ground to the exclusion of all other plants, even the bitter-weed (*Helenium tenuifolium*) being unable to grow through the close sod. It starts slowly but plants from seed planted in March are now (November 15) 8 feet in diameter and are unchecked by heavy frosts.

TERRELL GRASS (*Elymus virginicus*).—This is another native perennial which has received but little attention, but which is of considerable value for winter pasture. It grows most abundantly along creek banks and on the borders of the woods, but will grow on almost any soil. Its best growth is made during the fall and winter months, and is ready to cut in May, but the hay made from it is rather poor quality. Although a perennial it is best to take stock off the field sufficiently early to allow the roots to become strong enough to stand the summer drouth. Mr. A. S. Yarbrough, of Como, Mississippi, who has grown it for many years, says:

It will stand cold and heat without injury, but it can not stand pasturing in summer. It and Japan Clover are the only forage plants that we need, and about the only ones that are worth growing. If sowed in September on either plowed or pastured land, when the fall rains commence it will begin to grow and be from 2 to 10 inches high by December 15, after which it can be grazed in suitable weather through the winter and spring, when the land ought to be allowed to grow into Japan Clover or Bermuda, but never pastured during the summer.

Experience with this grass at the station indicates that, like the Australian oat, it will be of considerable value under good management, but of little use when it fails to receive the necessary attention.

TEXAS BLUE GRASS (*Poa arachnifera*).—This is one of the most widely advertised grasses in the whole South, but its real value for general cultivation is still problematic. It is a perennial, and emphatically a winter growing species. In favorable locations it begins its growth in October, and from November to May furnishes an abundance of luxurious pasturage. It matures its seed in April, and by the 1st of June the leaves become dry and withered, and little is seen of it until October. It is difficult to propagate from the seed, but can be increased rapidly by means of suckers, which are produced in immense numbers. From the fact that it takes its period of rest during the summer it is able to endure the longest drought without injury, and Professor Shelton reports that it is not injured by cold in Kansas. A rich loamy soil seems necessary for its successful growth, and in many places where the soil has appeared suitable the growth has been disappointing. At the Station it has been planted in a dozen or more places and with varying results. On rich light soil it has made a compact vigorous sod, which fully covered the ground in six months after planting, and has furnished excellent grazing for two years. Planted on equally good and well prepared ground with Bermuda it has lived, but has increased very little, and only occasional plants are to be seen during the late winter and spring months. On dry stiff clay it has nearly all died during the first season, and on the so-called "black prairie" lands

it has succeeded admirably. We have had no trouble in growing it from seed when sowed in beds and cared for, but have failed wholly in three attempts to grow it by sowing broadcast in the field.

RED TOP (*Agrostis vulgaris*).—On low and damp soils this is a valuable grass, as it remains fresh and green throughout the winter, furnishes excellent grazing, and is not easily killed by overflows, even when covered with water for two or three weeks at a time. We have found no better grass for marshy lands and “seepy” hillsides, and it has done moderately well where the ground was quite dry. During the first season after sowing it makes but little show, but becomes stronger and more dense with age, and maintains itself well against weeds and other grasses. It will produce one cutting of good hay, but its chief value here is as a winter and early spring pasture.

CRAB GRASS (*Panicum sanguinalis*).—This grass is found everywhere throughout the south in cultivated fields, where it springs up after cultivation has ceased for the season and makes from 1 to 2 tons per acre of excellent hay. On land which was plowed in February we have cut four crops of about 1 ton each this year. As its best growth is made in cultivated fields, and at a season when other forage is abundant, it is not of special value for grazing, but as the hay made from it is of very good quality, and costs nothing but the cutting, it is highly prized by many farmers.

BERMUDA (*Cynodon dactylon*).—This is one of the most widely diffused and best known of southern grasses, being found in all of the country south of the Ohio River. It is a perennial, but starts late in the season, and is killed down by moderate frosts. It succeeds best on rich bottom lands, where it will yield two cuttings in a season, making from 2 to 4 tons of hay per acre. This hay is of the very best quality, being especially valuable for horses and mules. When once established in a field it is very difficult to eradicate, and this is a decided objection to its general cultivation.

JOHNSON GRASS (*Sorghum halepense*).—This is at the same time one of the most valuable grasses and one of the most troublesome pests to be found in the South. It is a perennial which is easily propagated either by seeds or roots. It makes its best growth on rich bottom lands, where it soon occupies the whole ground, and will give three cuttings of about 2 tons each when in good condition. The hay is of excellent quality and is relished by all kinds of stock. The thick and fleshy roots soon become interlaced and matted in the soil, so that at intervals of three or four years the yield of hay is materially decreased, and the ground should be broken and harrowed, after which the grass becomes as vigorous as when first planted. The planter who wishes to grow hay and nothing else will find this a valuable species. As it requires a loose soil for its growth, it is of but little value for grazing, and but little is seen of it the second season that land is pastured. The objections to its cultivation are the rapidity with which it spreads to fields where it is not wanted, and the great difficulty of eradicating it from fields where it has become established. When fields are pastured it will soon almost disappear, but the roots remain alive and will again take possession of the field as soon as it is plowed. Instances are known where fifteen and even twenty years of continuous pasturing have failed to produce any appreciable effect on the vitality of the roots. It can be killed by covering with salt to the depth of an inch or more, and weekly hoeings

for a year will destroy most of it, but the work must be continued during the second season to make it complete.

Through the Gulf States are a number of forage plants, not grasses, which add largely to both the hay and pasture resources of the country, and which should be mentioned in this connection. The most important of these is Japan Clover (*Lespedeza striata*), which was introduced—probably from Japan—about thirty years ago, and which has now become thoroughly naturalized as far north as the Ohio River. It is an annual, but when introduced it perpetuates itself without care, and will make a fair growth on the poorest and driest of clay hills. It starts rather late in the spring, making but little show before June, but from that time on it grows rapidly and is eaten greedily by all kinds of stock. It continues its growth until killed by frost. On sterile soil its growth is flat and spreading, and it is fit only for pasture, but where the soil is of good quality it will grow from 20 to 30 inches in height and yield from 2 to 3 tons of hay per acre, which is fully equal in value to the best clover hay, and is probably the most profitable hay which can be grown here for feeding to milch cows or for fattening purposes.

ALFALFA (*Medicago sativa*) has been grown with varying results. On moderately rich and somewhat sandy soils it has proved very valuable for soiling purposes, furnishing cuttings as early as February, with frequent successions until late in summer. It also furnishes excellent winter pasture and is a profitable crop on suitable soils. On heavy clay, and dry hills, its growth has been weak and unsatisfactory. If pastured on alfalfa during the spring, cattle are seldom injured, but if not accustomed to it they are frequently attacked by bloat when turned into a field containing a rank growth, though it is probably no more dangerous in this regard than is red clover.

MELILOTUS (*Melilotus alba*).—This plant bears a close resemblance to alfalfa, but is larger and coarser in every way and is especially adapted to use on calcareous soils. It will make an excellent growth on the “rotten limestone” hills which are so barren that they will sustain no other plants, but is of almost no value on the red clays which contain but little lime. It is not generally liked by animals unaccustomed to its use, but it starts into growth very early in the spring when green forage is scarce, and if stock are turned onto it at that time they very soon acquire a taste for it and eat it readily through the remainder of the season. When grown for hay one crop can usually be cut in the fall, after sowing in the spring; and during the next season two crops may be cut, after which it should be allowed to mature seed. Unless cut early the stems become hard and woody, and in all cases care is necessary in handling in order to prevent the loss of leaves, which drop from the stems very easily. Excellent hay can be made by sowing melilotus on lands which have been set in Johnson grass, the mixture seeming to improve the palatability of both. From land cultivated in this manner we have seen three cuttings, of about 2 tons each, made in a season.

MEXICAN CLOVER (*Richardsonia scabra*).—This is an annual plant belonging to the *Rubiaceae* or Madder family, which has been introduced from Mexico. It makes its growth during the latter part of the season, coming up in cultivated fields after other crops have been laid by or removed, and by fall covering the ground with a dense growth of about 2 feet in height, and making a heavy yield of excellent hay. Enough seed will be left on the ground so that it will

not need to be sowed a second time. The plant is so succulent that the hay is somewhat difficult to cure, but is relished by all kinds of stock. It succeeds best on the sandy lands in the pine woods along the coast, but has made heavy crops when sown on rich soil at the station, and a moderate crop the second season on the same land without plowing. It is excellent for late summer and fall pasture, but is worthless at other times.

Many of the grasses and forage plants which are valued highly in the North have proved of little use when planted here. Among the more prominent are these:

TIMOTHY (*Phleum pratense*), which makes a weak growth for a year or two, but soon succumbs to the encroachments of the more vigorous native grasses and weeds. The apparent reason for this is that the bulbs and roots become so weakened by the continued growth to which they are stimulated during the "warm spells" of winter, that they are unable to withstand the strain of the summer heat and drouth.

KENTUCKY BLUEGRASS (*Poa pratensis*) is also practically a failure here. Where the soil is rich and moist, especially if partially shaded, it will make a weak growth, but will very rarely make the close and even sod so characteristic farther North. Repeated attempts to grow it here have been made during the last ten years, but total failure is the almost invariable result. Occasional patches of it may be seen, but these are not of sufficient size or evenness to be of any value either for pasture or lawn.

MEADOW FOXTAIL (*Alopecurus pratensis*) has done but little better than timothy, though it has afforded slightly better grazing.

None of the Fescue grasses (*Festucas*) have done well. They grow fairly during the cool weather, but the warm summer rains cause them to decay.

The Ray grasses (*Loliums*) have also proved worthless. They start readily from seed sown either in fall or spring and make a vigorous growth till warm weather comes, after which they dwindle and soon disappear. We have succeeded in preserving plots through the summer only with the greatest care, and from five sowings in the field of the Italian, English, and perennial varieties we have nothing left excepting an occasional plant. None of them seem able to stand our long summers, and can not be recommended for the Southern States.

RED CLOVER (*Trifolium pratense*) is of far less value here than in the Northern States. It starts readily, and may be cut two or three times during the season, but usually ceases to grow in July or August, and the fall rains stimulate such a vigorous growth of other plants that the clover is choked out and the next year the stand is "patchy" and irregular. On occasional fields the clover will maintain itself for several years and produce heavy crops, but such fields are quite exceptional.

EXPERIMENT STATION AT GARDEN CITY, KANSAS.

In the Report of the Secretary of Agriculture for 1889, in the botanical part, there was published an account of the organization of an Experiment Station at Garden City, Kansas, for the purpose of experimenting in the cultivation of grasses and forage plants suitable to the arid districts of the West. A statement was made

of the work which had been performed up to that time. I will now continue this report for the present year. The land was plowed and put into as good condition as possible, the newly broken ground was again plowed, the sod cut into pieces with the disk harrow, and further pulverized by means of a special thousand-toothed harrow, invented by the superintendent of the Station, Dr. J. A. Sewall. Two thousand pounds of seeds of native grasses had been collected the preceding autumn, and these, together with several hundred pounds of foreign seeds, were sown. The native seeds were of the following kinds; the amount of land for each kind is given:

<i>Chrysopogon nutans</i> , 2 acres.	<i>Andropogon provincialis</i> , 2 acres.
<i>Panicum virgatum</i> , 20 acres.	<i>Andropogon Hallii</i> , 1 acre.
<i>Agropyrum glaucum</i> , 5 acres.	

The foreign grasses were as follows:

<i>Festuca elatior</i> , 5 acres.	<i>Festuca heterophylla</i> , 2 acres.
<i>Arrhenatherum arenaceum</i> , 1 acre.	<i>Festuca ovina</i> , 2 acres.
<i>Holcus lanatus</i> , 2 acres.	<i>Elusine Corocana</i> , 3 acres.
<i>Agrostis stolonifera</i> , 1 acre.	<i>Cynodon dactylon</i> , 1 acre.
<i>Bromus inermis</i> , 3 acres.	<i>Lolium perenne</i> , 2 acres.

Of foreign forage plants were the following:

Sainfoin (<i>Onobrychis sativa</i>), one half acre.	Goats' Rue (<i>Galega officinalis</i>), one fourth acre.
Spurry (<i>Spergula maxima</i>), one half acre.	Hairy Vetch (<i>Vicia villosa</i> and <i>Lathyrus hirsutus</i>), one fourth acre.
(<i>Lotus major</i>), one half acre.	Bokhara Clover (<i>Melilotus alba</i>), one eighth acre.
Serradella (<i>Ornithopus sativus</i>), one half acre.	Alfalfa (<i>Medicago sativa</i>), 10 acres.

In addition there were sowed and planted on the 160-acre field, 40 acres winter rye, sowed in September, 1889; 8 acres Polish wheat, and 80 acres in different varieties of sorghum.

The result for this year, so far as the grasses were concerned, was very disappointing. Most of the kinds germinated and made a satisfactory growth up to June 1, after which for want of rain they suffered sadly, and most of them at the end of the season were complete failures. Of those surviving, the most promising kinds were *Bromus inermis*, *Panicum virgatum* and *Agropyrum glaucum*. The two *Andropogons* and the *Chrysopogons* mainly failed, probably on account of the seed having been collected before it was mature. The failure of some is attributed to being sown on new ground in which the old sod had not become thoroughly disintegrated.

Of the forage plants *Galega officinalis*, *Anthyllis vulneraria*, *Onobrychis sativa*, and *Medicago sativa*, although they suffered much from the drouth, yet maintained life, and with a favorable winter will probably recover vigor the coming spring. There is encouragement to expect this from the fact that the same plants of last year's sowing maintained a vigorous growth in spite of the drouth of this season, some of them even affording a good cutting for hay. The most promising of these are: (1) Sainfoin (*Onobrychis sativa*); (2) Burnet (*Poterium* sp.); (3) Goats' Rue (*Galega officinalis*); (4) Spanish Clover (*Anthyllis vulneraria*).

The *Melilotus alba* or Bokhara Clover made a good crop, as it will no doubt do in the driest season, the only difficulty being that cattle do not like it and have to be trained to eating it. It is maintained, however, by many who raise it in the south that cattle are readily brought to eating and relishing it, and if that circumstance

can be depended upon there need be no want of abundance of forage on the most arid soils. But the discouragements of this year with respect to the growth of the grasses, were partly compensated for in another direction. Knowing that in California, Utah, and Arizona, where perennial grasses have not succeeded, some of the grains, as barley and wheat, are cultivated as forage, an experiment was undertaken with winter rye. About 40 acres of this were sown in September, 1889. This came up and grew well until winter, and in the spring of the present year up to the 1st of June, when the Superintendent of the Station (Dr. J. A. Sewall, of Denver) said it was equal to any rye he had seen in Colorado even with irrigation, and if the rainfall for June had been an average one it was estimated that it would have yielded 25 bushels per acre. About 2 acres were cut and made into hay, the rest grew until it was harvested, when it threshed out about 17 bushels per acre. Another experiment was with Polish wheat (*Triticum Polonicum*). About 10 bushels of this was sown in March and harvested about the 25th of June, maturing in about one hundred days. Up to the 1st of June this was very promising, but the drouth following prevented its full development; still it gave at harvest 8 bushels per acre of excellent wheat of this variety. In fact it attracted a great deal of attention. A sample of it was sent to the State Fair at Topeka, and would have taken first premium had it not finally been ruled out of the wheat list and classed with rye. The surplus of the rye and wheat, after reserving sufficient for the use of the Station, was gratuitously distributed to the farmers of the surrounding country for seed purpose, in quantities of from one half a bushel to 2 bushels, and it was eagerly sought for. The lesson of this experiment is that in the most unfavorable season it seems possible for the farmer to provide a large amount of fodder, as well as a fair quantity of grain, by utilizing the winter and spring rains.

In addition to what has been already mentioned, about 80 acres were planted to different varieties of sorghum, all of which presented an appearance of great thrift up to the 1st of June, when the drouth, and those peculiar desiccating winds to which Kansas is subject, arrested their development and ruined the greater part of the yield; only one variety, locally called Jerusalem corn (apparently a variety of Millo Maize), maintained a good degree of hardiness and vigor and matured a fair crop of seed, which is of great value as a feed for poultry, hogs, and other animals.

These experiments illustrate and emphasize the line upon which such investigations should be pursued. It is very rarely that the seasons fail at both ends of the year, and by a proper selection of grain, grasses, and other economic plants, there will rarely be a total failure of crops. The early maturing winter and spring grains and the hardier kinds of sorghums may be pretty confidently relied upon for food crops and fodder; then there is little doubt that the grasses and forage plants now under trial will prove successful, and other plants, as sugar-sorghum, corn, oats, beans, castor beans, root-crops, etc., may take the chances of the seasons, which three times out of four will probably be favorable to them. Certainly the immense importance of making these arid lands inhabitable will justify most protracted and exhaustive experimental work at this and other stations.

During this year the rainfall at the Station from the 1st of January until the 1st of June amounted to 9 inches, and from the 1st of

June until the 25th of October a trifle over 3½ inches, making less than 13 inches during nearly ten months, considerably less than the average of many years, and sufficient to account for the failure of many of the grasses.

By the kindness of General A. W. Greely, I am able to present a table of temperature and rainfall at Dodge City, Kansas, for a period of sixteen years. This place is on the 100th meridian, a degree farther east than Garden City. It will be noted that there is great irregularity in the amount of rainfall, particularly during the summer months. During the sixteen years given, the quantity for those months varies from 4.67 inches (for 1890) to 18.89 inches (for 1884). Only two other years of the sixteen was the summer rainfall nearly as low as the present one, viz, in 1876, 4.79 inches, and in 1882, 5.63 inches. The chances are that such a dry summer as the present will not occur again in many years, and if the grasses now living can be carried over the year they may be fairly established. The table of temperature gives only the average for each month. I am informed that for many days during the summer, at the Station, the thermometer reached from 103° to 110° in the shade. Very little vegetation can pass through such an ordeal as this intense heat combined with the prevailing drought.

Mean temperature at Dodge City, Kansas, since January, 1875, as recorded by the United States Signal Service Office.

Months.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
January	13.2	35.3	23.9	32.0	23.9	35.2	20.1	31.1	22.1	25.6	18.4	16.5	27.1	22.8	28.9	27.2
February	29.8	41.5	37.1	38.2	32.5	39.3	26.8	38.1	26.2	28.5	25.8	35.0	30.5	37.7	29.0	32.4
March	38.1	34.7	42.6	49.3	47.7	40.2	39.8	46.8	40.8	41.8	40.9	39.0	44.6	36.5	45.8	42.5
April	47.9	56.6	50.1	55.9	57.0	54.8	53.1	52.5	53.0	49.1	54.4	51.0	54.4	56.9	56.6	54.2
May	65.4	64.5	62.7	61.9	68.9	68.2	63.6	56.5	60.5	59.5	58.7	67.5	65.4	60.5	63.7	63.6
June	75.4	71.2	70.6	70.5	76.0	74.7	76.9	73.1	70.5	71.2	71.2	71.2	74.0	74.5	69.8	75.0
July	75.5	79.6	77.5	80.0	80.4	76.4	77.8	74.6	76.2	76.6	76.3	78.2	78.7	80.0	77.5	82.4
August	74.6	77.2	76.2	79.0	75.6	74.8	78.0	73.9	71.7	71.9	73.1	78.2	74.8	74.4	76.9	76.4
September	68.7	66.7	68.4	67.9	66.2	65.8	67.7	68.0	64.1	70.2	66.0	67.6	68.2	67.8	66.3	65.2
October	56.6	52.6	51.7	54.0	59.5	51.6	56.5	56.6	50.8	57.6	57.3	58.8	53.7	55.1	55.6	55.5
November	39.9	38.4	38.6	43.4	40.7	26.2	37.7	40.1	41.8	41.6	45.2	38.1	42.5	41.2	37.4
December	40.7	21.1	39.0	23.8	25.7	24.9	36.9	31.7	34.8	21.0	36.6	28.6	28.9	38.4	44.6
Means	51.0	53.2	53.5	54.4	54.3	52.9	53.0	53.6	51.1	51.2	51.5	52.5	53.6	53.8	54.3

Rainfall at Dodge City, Kansas, since January, 1875.

Months.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
January	0.12	0.00	0.18	0.21	0.87	0.00	0.15	0.52	0.44	0.08	0.52	1.82	0.07	0.23	1.69	0.42
February	0.10	0.05	0.56	1.13	0.08	0.00	1.63	0.22	1.42	0.28	0.47	0.46	0.53	0.73	0.34	0.39
March	0.04	3.59	0.25	1.01	0.17	0.04	0.50	0.24	0.42	1.91	0.75	1.50	0.17	0.93	1.38	0.05
April	0.72	0.16	3.38	1.06	0.40	0.11	2.38	0.68	2.40	1.07	1.39	1.90	2.46	4.08	2.12	2.90
May	2.26	1.15	4.96	4.63	0.90	3.01	12.82	3.87	5.41	4.48	4.07	0.40	3.69	2.86	1.54	1.19
June	0.64	2.53	3.92	2.19	4.40	1.59	1.77	1.51	4.31	7.67	2.02	5.47	4.00	5.16	3.43	1.00
July	3.28	2.26	1.79	1.61	3.90	4.00	5.06	3.04	2.61	6.40	6.03	2.07	1.00	4.07	2.02	0.22
August	2.05	1.03	4.09	4.48	3.75	5.17	2.36	1.07	5.66	4.82	1.80	2.46	2.28	3.00	2.14	3.45
September	1.32	2.13	0.50	0.76	0.80	0.32	3.13	0.15	1.32	0.23	3.48	2.33	0.14	0.78	0.86	0.57
October	0.06	1.00	3.34	0.09	0.00	1.42	2.19	1.62	3.32	1.50	1.06	0.45	0.48	0.81	2.88	0.89
November	0.00	1.35	0.56	0.60	0.04	2.43	0.95	0.11	0.12	0.83	0.36	0.24	0.35	0.06	0.77
December	0.09	0.15	4.36	0.19	0.12	0.03	0.61	0.11	1.07	1.10	1.76	0.25	0.54	0.23	0.00
Total	10.69	15.40	27.89	17.96	15.43	18.12	33.55	13.14	28.50	30.36	23.71	19.35	15.71	22.94	19.17

GRASSES FOR ARID DISTRICTS.

Many inquiries are made as to what grasses and forage plants can be tried in the arid districts. In general I will say, such kinds as are observed to thrive and produce a large or at least a fair amount of nutritious forage in the region under consideration. In our experiments we have rather acted on the supposition that any and everything might be given a trial, notwithstanding the probability that nine tenths of all kinds tried would prove failures. Repeated failures with any particular kinds will soon eliminate such from the list of further trials, and cause us to continue work with a greatly reduced number. Yet we may get much help from the establishment of some general principles.

(1) No perennial grasses with broad leaves can be expected to answer the purpose. Such kinds are of vigorous growth and require a large supply of water to come to maturity.

(2) Grasses with strong, deeply penetrating roots, are generally best adapted to endure long periods of drouth.

(3) Grasses with bulbous enlargement at the base of the culm, and those with thickened rhizomas, and those with creeping and rooting stems are generally able to bear drouth on account of the nutriment stored up in their tissues. Some species of *Panicum* and some of *Phalaris* are promising kinds, from this peculiarity.

(4) Some kinds produce a large quantity of foliage near the ground, which serves as mulch to protect the soil beneath from rapid evaporation, and are able hence to survive drouth. Of this kind is *Bromus inermis*, a European grass recently introduced; *Lolium perenne*, or perennial rye grass; and *Festuca elatior*, or tall fescue. The common grama grass, *Bouteloua oligostachya*, and buffalo grass, *Buchlæ dactyloides*, owe their value largely to the property of forming a close mat of interwoven stems and leaves upon the surface of the ground. *Sporobolus cryptandrus* and *Sporobolus airoides*, two kinds of wire grass native to the plains, owe their persistence to their hold upon the ground by means of their strong penetrating roots.

(5) Generally the grasses for cultivation in arid soils are to be sought for in the arid country itself. They are existing there, but in small quantities or in special localities, and are waiting to be looked up and brought under the protecting influence of cultivation. True, there are several desert regions where at present agriculture is impossible without irrigation, but even in southern New Mexico and Arizona there are broad elevated plains where water is obtainable within less than a hundred feet, and where there is evidence in the existing vegetation that systematic cultivation of properly selected grasses might be expected to secure a greatly increased production of useful vegetation. The grasses which I would select for cultivation there, are very different from those I would recommend for Kansas and similar northern regions. Among the species I would select in that region are: (1) *Panicum virgatum*, sometimes called Switch grass; (2) *Panicum bulbosum*, with thickened bulb-like culms; (3) *Setaria caudata*, a kind of perennial pigeon-grass; (4) *Andropogon scoparius*, or broom-grass; (5) *Phalaris intermedia*, or Wild Canary grass; (6) *Sporobolus airoides*, and (7) *Sporobolus Wrightii*, sometimes called Saccatone; (8) *Pappophorum laguroideum*, with no common name. In addition to those some of the

European grasses and forage plants which are under trial at Garden City may be found suitable.

NOXIOUS WEEDS.

By F. V. COVILLE.

ORDER COMPOSITÆ.

Horseweed (*Ambrosia trifida*).

[Plate I.]

Plant annual, robust. Stem simple, erect, terete, striate, hispid, 3 to 10 or even 15 feet high, often 1 inch in diameter at the base. Leaves opposite, large, petiolate, 3-lobed, strigose on both surfaces; lobes oblong to lanceolate, acuminate, serrate; upper leaves often oblong-lanceolate and not lobed. Inflorescence a paniculate leafy cyme of slender racemes. Heads monœcious; staminate pendulous at the ends of filiform pedicels (about one fourth of an inch long), with a flat involucre about one fifth of an inch in diameter; pistillate few, sessile at the base of the raceme, 1 to 3 together in the axil of a leafy bract. Staminate flowers minute, several in each head; pistillate flowers single in the head, the involucre surrounding it closely and resembling an ovary. Fruit seed-like, obovoid, slightly compressed, one third to one half an inch long, about 6-ribbed, with several sharp tubercles toward the apex.

Horseweed is a native of the United States, and is distributed throughout the country east of and extending somewhat into the Great Plains. It grows in all tilled soils, but especially in rich river bottoms, forming, if left to itself, a dense growth and choking out most other plants. It is easily subdued by mowing and plowing. In copses and open woods along streams and by the margins of fields it is usually left to mature its fruit, and it is a matter of economy to mow such patches of the plant as often as they flower. The fruit, which exactly resembles a seed, is undoubtedly transported and widely scattered by the floods characteristic of alluvial plains, so that something more than the local extermination of the plant is necessary to prevent its growth.

One correspondent from Texas says that the plant makes a fodder which is freely eaten by horses and cattle.

Orange Hawkweed (*Hieracium aurantiacum*).

[Plate II.]

Perennial by slender rootstocks and by runners. Stem simple, erect, 1 to 1½ feet high, nearly leafless, densely hirsute, the hairs toward the apex of the stem black at the base. Leaves mostly radical, oblong-lanceolate, denticulate, hirsute on both sides, sessile, those of the stem 2 or 3, all but the lowest reduced to bracts. Heads in a bracted-cyme; peduncles with black glandular hairs and a close brown coating of stellate hairs; involucre about one third of an inch in diameter, its bracts linear-lanceolate, little imbricated, provided on the back with straight, glandular, and stellate hairs. Flowers all perfect, with ligulate orange-colored corollas. Achenia about 1 line long, dark brown, linear in outline, terete, 10-ribbed, truncate; pappus a row of dirty-white capillary bristles.

This plant has been recently introduced into the eastern United States from Europe. It has appeared thus far mostly in pastures and roadsides, where the grass is not tall, a single plant giving rise in a few years, by its rootstocks and runners, to a large patch tenacious of life, and taking almost complete possession of the soil.

When to this characteristic is added its capability of producing a large number of seeds adapted to dispersion by the wind, an idea of its pestiferous nature may be obtained. The orange colored flower heads are strikingly pretty.

ORDER SCROPHULARIACEÆ.

Toad flax (*Linaria canadensis*).

[Plate III.]

Plant perennial, spreading by rootstocks. Stem erect, usually unbranched, commonly 1 to 2½ feet high, smooth. Leaves numerous, alternate, sessile, linear to linear-oblongate, 1 to 2½ inches long, one twelfth to one fourth of an inch broad, acute at the apex, smooth. Flowers short-pedicel in an erect terminal raceme, elongating as it flowers to a length of sometimes 8 inches. Calyx of 5 ovate acute sepals about one sixth of an inch long, not enlarging in fruit. Corolla pale yellow, the parts united into a tube, irregular, 2-lipped, the orifice closed, three fourths to 1 inch long, with a straight, downwardly projecting spur; upper lip 2-lobed, erect; lower lip 3-lobed, bearded at the base, reflexed, spreading, middle lobe much the smallest. Stamens 4, borne on the base of the corolla-tube, anthers included. Ovary 2-celled; placentæ axile; ovules numerous; style 1, filiform, not projecting from the corolla; stigma capitate-bilobed. Fruit an ovoid obtuse pod. Seeds small, flat, circular, surrounded by a wing.

In appearance this is a pretty and, in mass, a striking plant, but when bruised it has a characteristic rank odor. It is native in Europe, but fully naturalized in the eastern United States in pastures, meadows, and roadsides. When once started in a place it spreads rapidly and persistently by its long rootstocks underground. Its favorite situation is in rather dry soils, and careful and persistent cultivation is required to exterminate it.

ORDER CONVULVULACEÆ.

Clover dodder (*Cuscuta trifolii*).

[Plate IV.]

Plant annual, parasitic without chlorophyll. Roots none. Stem filiform, yellow, twining, attached to its host by sucker-like disks. Leaves reduced to inconspicuous scales. Flowers white, about one half of an inch broad, in small glomerate clusters. Sepals 5, ovate acute. Corolla gamopetalous, twice as long as the calyx, 5-lobed; lobes spreading, acute. Stamens 5, inserted on the corolla, each subtended by a large ciliate scale. Styles 2. Stigmas 2, elongated, not ciliate. Fruit a circumscissile capsule.

This parasite is a native of Europe, supposed to have been introduced into the United States with clover seed. It has appeared occasionally in various parts of the United States and within the last two years has been prevalent in Missouri.

There are twenty-one species of *Cuscuta* native in the United States, all leafless twining plants, with filiform stems, parasitic on various hosts. Three introduced species are known: One from Chili on alfalfa, another from Europe on flax, and the third the one under consideration. Clover dodder may be readily distinguished from all our other species, except flax dodder, by its elongated instead of capitate stigmas, and from that species by growing upon clover instead of flax.

A clover field usually becomes infested with the parasite from the sowing of seed containing that of dodder. The dodder seeds germinate in the ground, sending up slender leafless stems, which twine

about the clover and obtain nourishment from it through the disks that are soon developed. The lower part of the stem then dies and connection with the ground is lost. The yellow threads continue to develop rapidly until a circular patch of clover is covered by it, and the host becomes so weakened by the loss of its sap that it finally turns brown, dies, and rots.

The remedy is first to obtain a pure quality of clover seed. Dodder seeds are similar to those of clover, but of smaller size and capable of separation by screening. If a meadow is but slightly infested, each patch containing the parasite should be mowed and destroyed as soon as seen, and if no plants are allowed to seed the clover will be saved. When, however, a meadow is thoroughly sprinkled with dodder the whole must be plowed and other crops planted for a few years, when all the dodder seeds will have germinated and died. Under no circumstances should an infested crop be saved for seed.

ORDER PLANTAGINEÆ.

English Plantain (*Plantago lanceolata*).

[Plate V.]

Plant perennial. Rootstock short, thick, nearly erect. Leaves all radical, long-petioled; blade oblong-lanceolate to linear-lanceolate, acute or acuminate at both ends, 3 to 5, rarely 7 ribbed, denticulate, from pilose to nearly smooth, 3 to 6 inches long. Inflorescence a solid spike about one third of an inch in diameter, from 2 inches long to very short, borne on a naked slender scape about twice as long as the leaves. Flowers perfect, single in the axil of an ovate, 1-nerved, papery bract shorter than its flower. Sepals 3 (one composed of two united), papery, ovate; one 2-nerved, the others 1-nerved. Corolla in one piece, with four abruptly spreading, ovate, 1-nerved lobes, each about 1 line long. Stamens 4, borne on the tube of the corolla, not extending from it. Ovary 2-celled, 2-ovuled. Seeds 2, oval, rather flat, hollowed on one face, about 1 line long.

This plantain has long been naturalized in the United States, coming originally from Europe. It is now found throughout almost the entire country, in pastures, meadows, and lawns. Its seed is easily distinguished from that of grasses and other forage plants, which should always be examined before planting. If the weed is once established, plow it under and cultivate the soil for a year or more.

It has often been used as a forage plant in England, but in the United States it has proved thus far undesirable.

ORDER GRAMINEÆ.

Bur Grass (*Cenchrus tribuloides*).

[Plate VI.]

Plant annual. Stem spreading and branching at base, from a few inches to 3 feet high. Leaves of the stem 3 to 10, usually glabrous; blade 6 inches long or less, 1 to 2 lines broad, flat or sometimes involute. Inflorescence a spike of burs, these consisting of a cluster of two or three spikelets inclosed in an involucre provided with barbed spines and bristles. Flowers in each spikelet 2, one staminate, the other fertile, grains when mature remaining inclosed in the involucre.

This native grass is common throughout the southern portion of the United States and Mexico, extending northward in warm, sandy regions into the Northern States. In some parts of the Great Plains it takes almost entire possession of cultivated fields late in

the season, ripening its grains for the next year, and offering great annoyance to cattle and to men. The barbed spines easily penetrate the flesh and are painfully irritating.

Thorough cultivation should be adopted until the crops are harvested, and after that sufficient plowing to prevent the maturing of the grains.

NEW FODDER GRASSES.

We add here the figures and descriptions of two grasses which are considered as having much value for fodder in the South. They would have been included in a former publication but that the plates could not be prepared in season.

ORDER GRAMINEÆ.

Pearl Millet, Cat-tail Millet, Egyptian Millet (*Pennisetum typhoideum*).

[Plate VII.]

A tall, erect, thick-stemmed grass growing to the height of 6 feet or more. It has an abundance of broad leaves and is terminated by a spike-like panicle, which is compact and cylindrical; a foot long, and resembling the common cat-tail. The panicle is studded with small obovate grains, which are surrounded at the base by numerous coarse hairs or bristles. It is probably a native of the East Indies, where it has long been cultivated, and forms an important article of food. It is also cultivated in Arabia and in Central Africa. It has been cultivated in the Southern States for fodder and on rich ground produces an enormous yield. It may be cut several times during the season, and after cutting sends up numerous sprouts with broad, succulent leaves, and juicy sweet stalks. On rich ground it produces so abundantly as to make it difficult to find room to cure it into fodder. Cattle and horses are very fond of it both green and when cured. It is an annual, and will not mature its seeds except in a warm climate.

ORDER GRAMINEÆ.

Teff (*Eragrostis abyssinica*).

[Plate VIII.]

An annual grass growing to the height of 2 or 3 feet. The stem is rather weak and branching, the large top when in fruit bending over gracefully. The panicle is large and diffuse, the branches fine and much subdivided, the spikelets small, several flowered, and on slender pedicels.

This grass was introduced from Abyssinia, where it is cultivated under the name of Teff, and is used by the natives as food. It has been cultivated in some of the Southern States, and is said to be remarkably productive and valuable for hay. It may be cultivated at altitudes of 6,000 to 7,000 feet, where maize can hardly thrive. It is said to mature in four months and to yield forty times its weight of seed. The traveler, Bruce, mentioned Teff with approval. It is said to make a white, delicious bread. The seed has been diffused by the Royal Botanic Garden of Kew, England, and recently by this Department to several of the Experiment Stations, where it is undergoing a trial.

LIST OF PLATES.

REPORT OF THE BOTANIST.

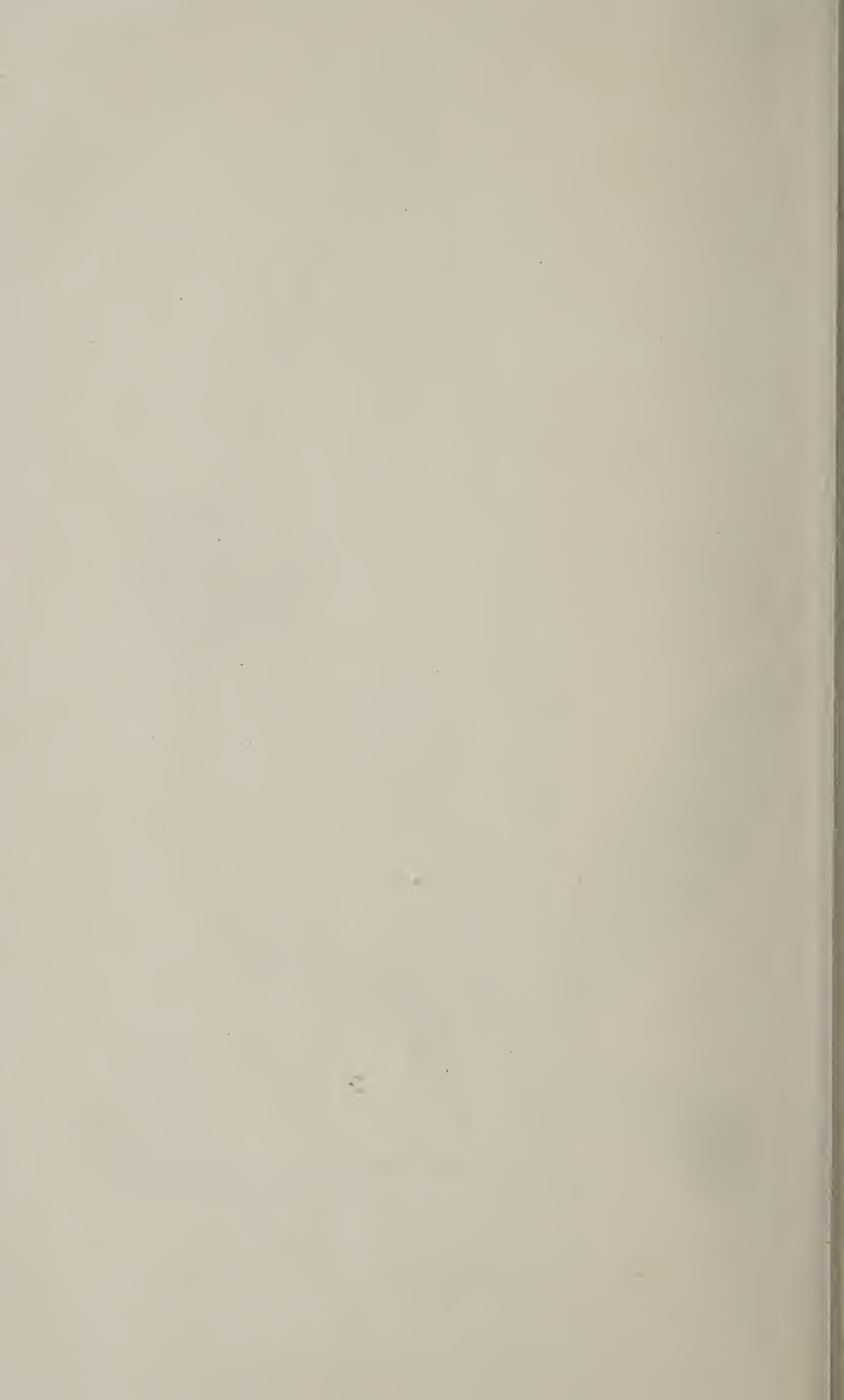
- Plate No. I. *Ambrosia trifida*.
II. *Hieracium aurantiacum*.
III. *Linaria canadensis*.
IV. *Cuscuta trifolii*.
V. *Plantago lanceolata*.
VI. *Cenchrus tribuloides*.
VII. *Pennisetum typhoideum*.
VIII. *Eragrostis abyssinica*.



HORSE WEED (AMBROSIA TRIFIDA).

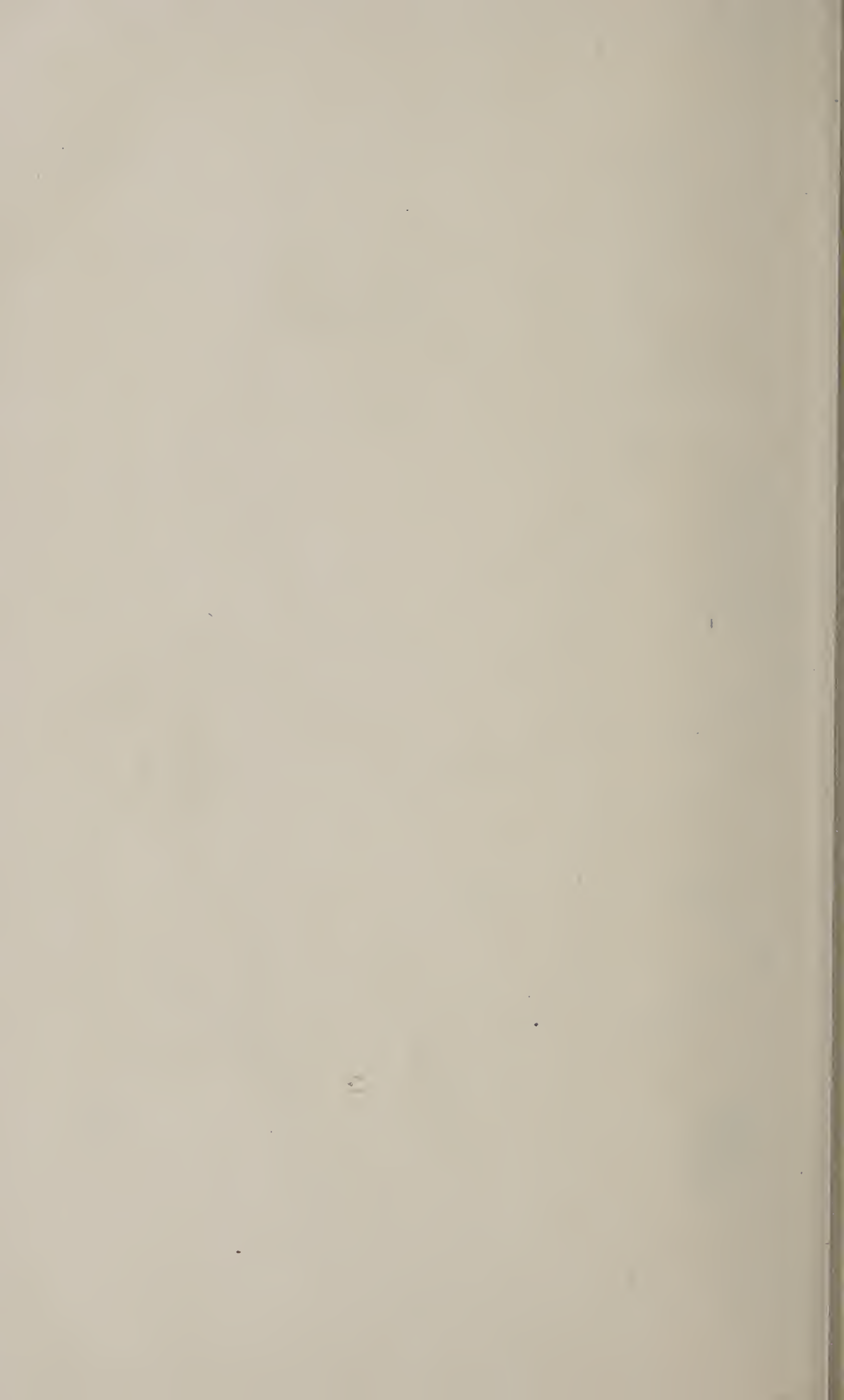


ORANGE HAWKWEED (*HIERACIUM AURANTIACUM*).





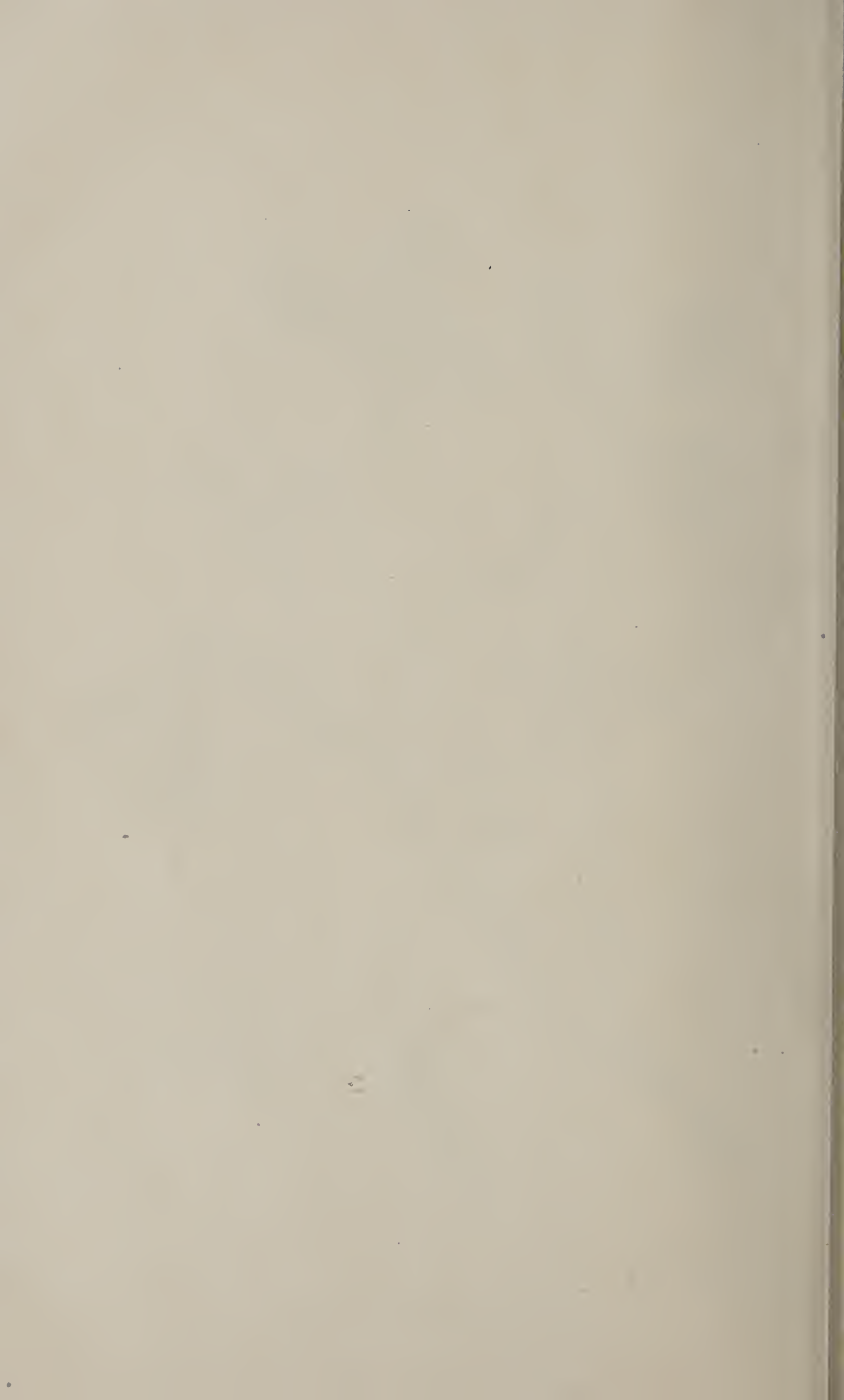
TOAD FLAX (*LINARIA VULGARIS*).





L. R. Stowell del.

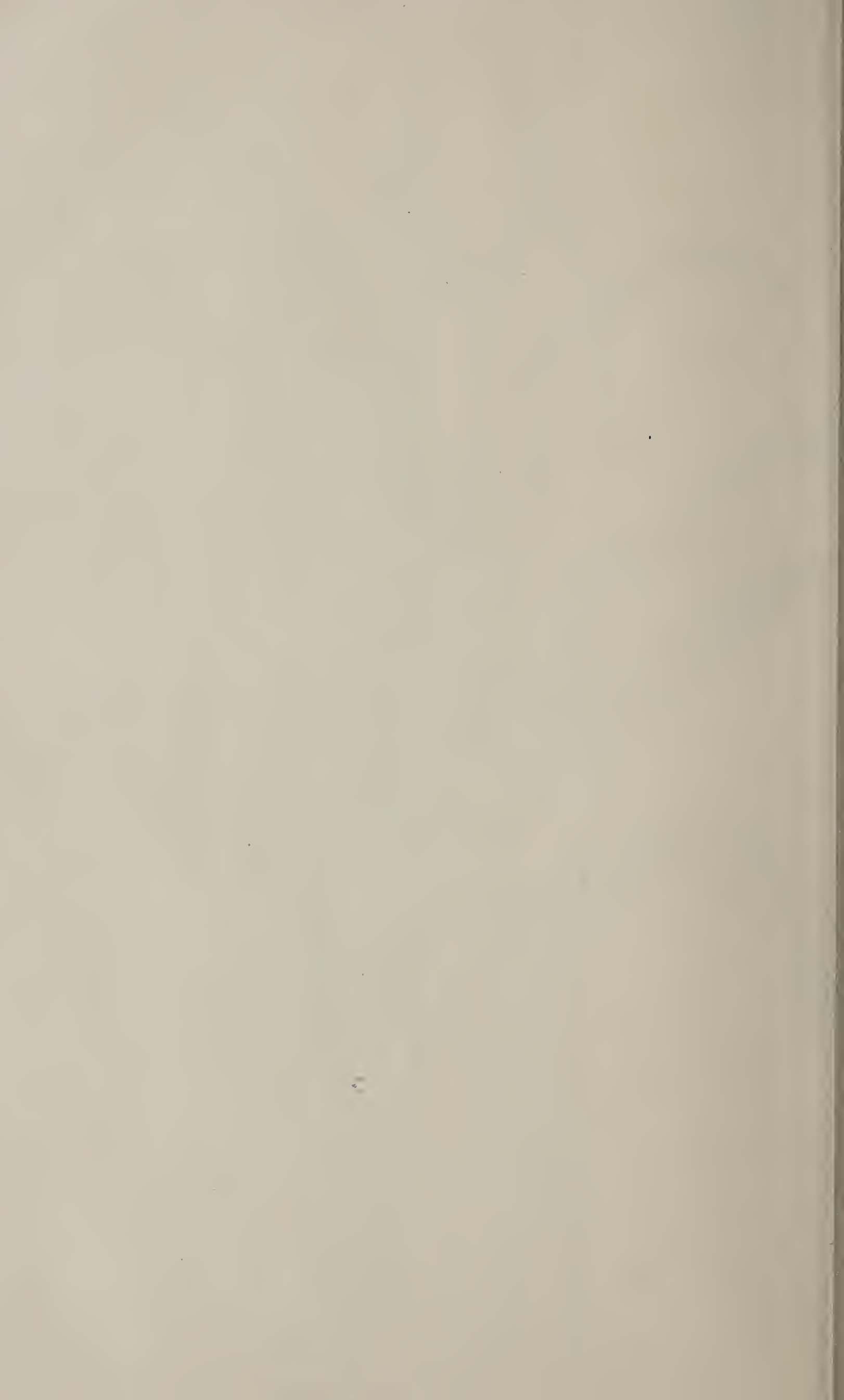
CLOVER DODDER (*CUSCUTA TRIFOLII*).

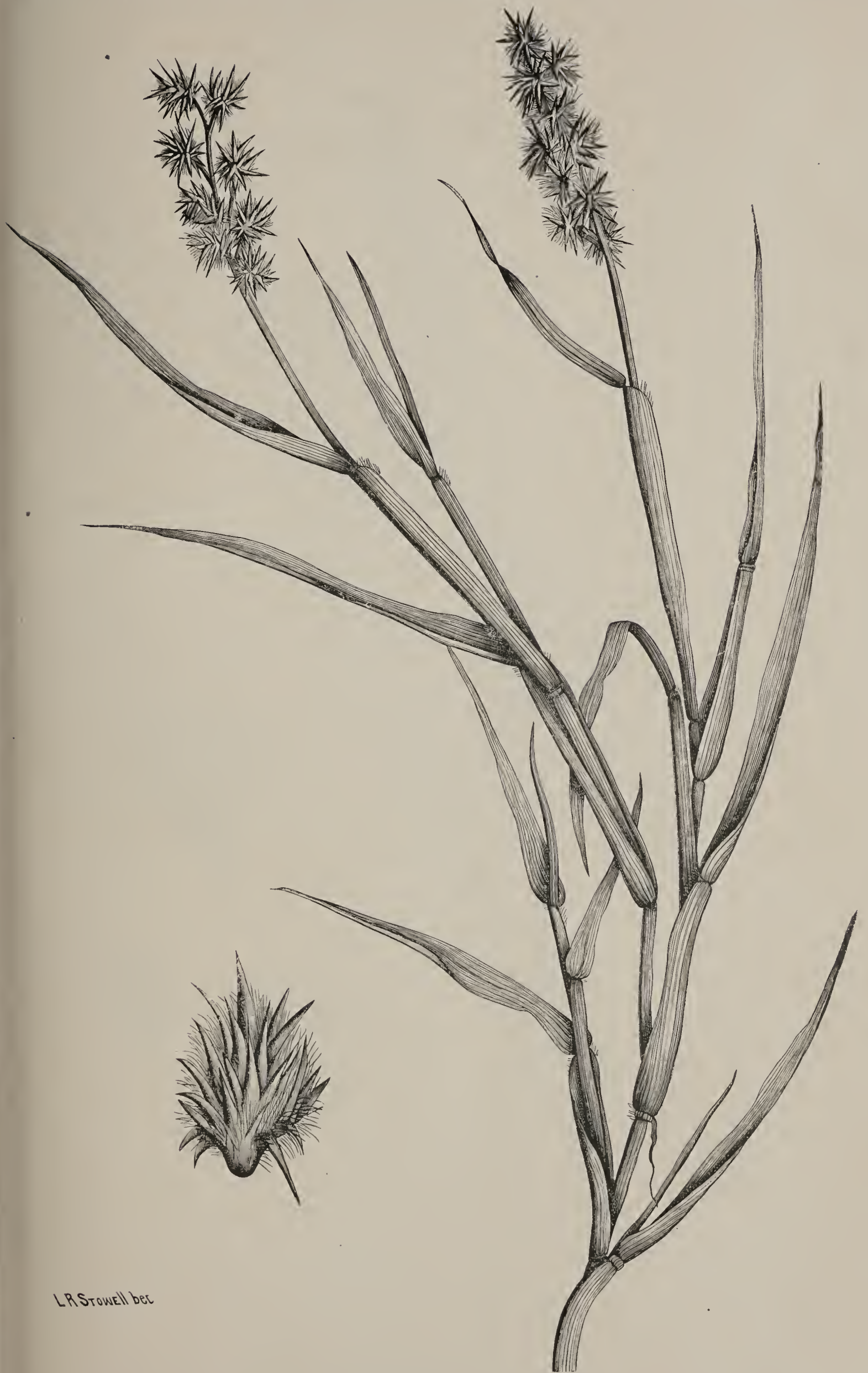




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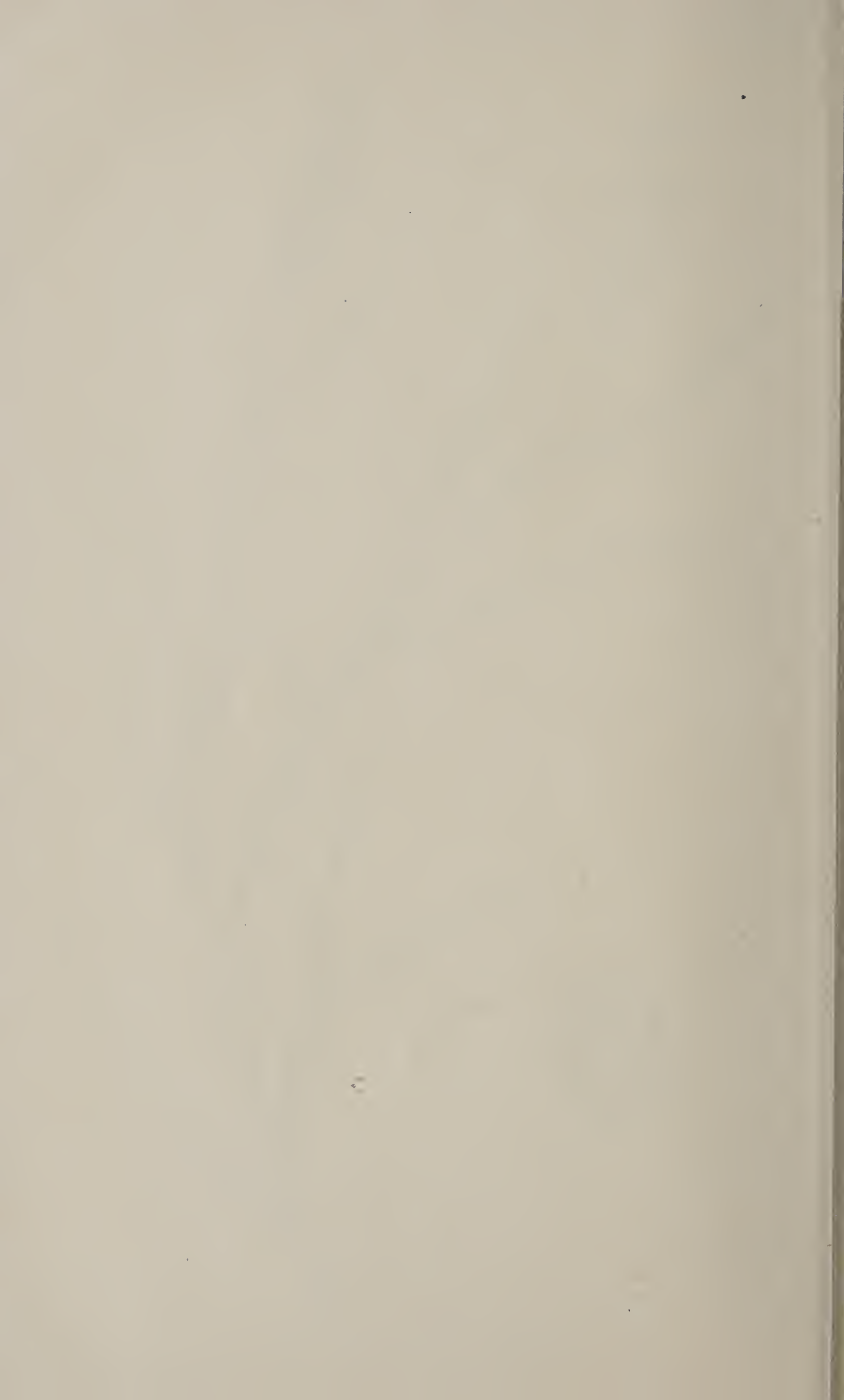
ENGLISH PLANTAIN (*PLANTAGO LANCEOLATA*).





L. R. Stowell del.

BUR GRASS (CENCHRUS TRIBULOIDES).





PEARL MILLET (*Pennisetum typhoideum*).



W. R. SCHOLL del.

TEFF (*ERAGROSTIS ABYSSINICA*).

